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Lewis Research Center



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IMPULSE COMMUTATING CIRCUIT WITH TRANSFORMER TO LIMIT REAPPLIED VOLTAGE

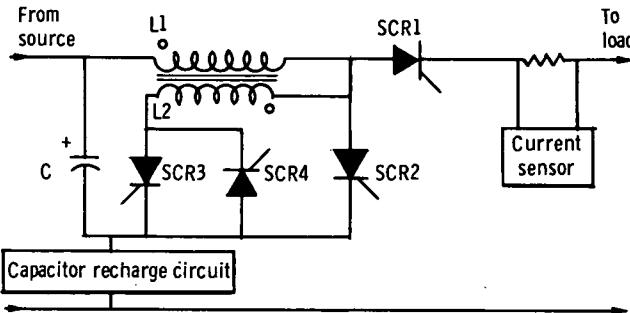


Figure 1. - Basic commuting circuit.

A new circuit to achieve commutation of a switching silicon controlled rectifier (SCR) has been developed to open a circuit with currents flowing up to values of 30 amperes. This circuit utilizes a new concept of switching, which halves both current and voltage in the middle of the commutating cycle thereby lowering the size and weight requirements.

The commutating circuit has performed successfully throughout the temperature range of 218 to 373 K (-67 to 212°F). It can be turned on or off by command and will remain on in the absence of a load due to the continuous gate.

A schematic diagram of the commutating circuit is shown in Figure 1; its operation is illustrated in Figure 2. In operation, SCR 1 carries the load current. Capacitor C is precharged to 450 volts in the polarity shown. A manual shut down or trip level overcurrent is sensed at the time t_0 . SCR 2 is triggered on at this time dumping the capacitor across L1 and driving the anode of SCR 1 negative so that it stops conducting almost instantly. The current flowing through L1 continues to flow but now goes through SCR 2. When the voltage on SCR 1 comes up to zero at time t_1 , the voltage has been negative on SCR 1 long enough to keep SCR 1 from conducting with no gate even though the voltage on the anode is now reapplied in the positive direction.

At time t_2 , the voltage on the capacitor is zero and the current through the inductor is at maximum. SCR 3 is now gated on. Until this time, L2 has been in an open circuit with no current flow. Now that current can flow through L2, the magnetic field in the inductor is the same but the number of windings has doubled so that the current, almost instantly, goes to half the peak value. The oscillation of the circuit continues at half the frequency. The current flows through L1 and L2 in series, which have capacitor voltage across them, so that SCR 2 now has half the capacitor voltage across it, in reverse. Thus, it is turned off. The same voltage is applied to SCR 1; i.e., half of the voltage that would be applied if SCR 3 did not conduct. This permits lower ratings for SCR 1.

As the oscillation continues, the current goes through zero and SCR 4 is gated on to permit the current to flow in the opposite direction. This is at time t_3 . The capacitor is now charged to a voltage representing the energy of its initial charge plus the energy stored in the inductor L1 at time t_0 , exclusive of losses. At time t_4 , the voltage across SCR 1 is back down below source voltage, the capacitor voltage is going through zero, and SCR 4 is carrying maximum current. By time t_5 , the capacitor is nearly recharged (except for losses), SCR 3 is turned off, current ceases to flow and the voltage on SCR 1 goes back to source voltage. The circuit is now reset and is nearly ready

(continued overleaf)

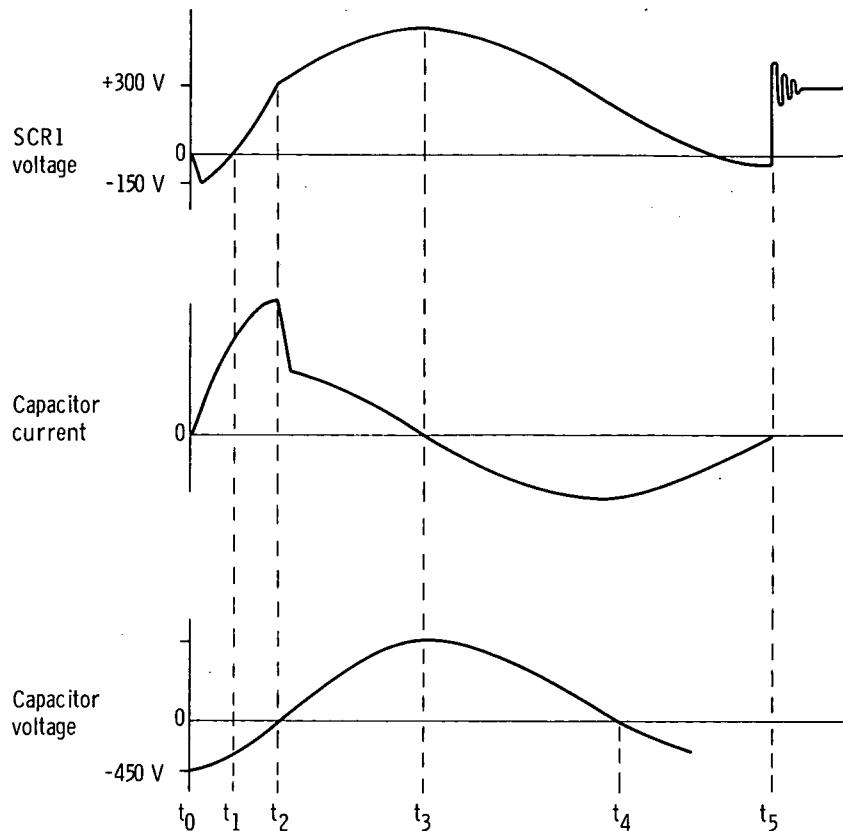


Figure 2. - Principal waveforms of commuting circuit.

to be turned on again. In reality, the charge on the capacitor will be built up to its final precharge value by the capacitor recharge power supply before it is desirable to turn the circuit on again. The whole commutation cycle takes place in less than $\frac{1}{2}$ -millisecond and occurs with no reference to the return circuit of the power source so that minimum transient disturbances are caused.

NOTES:

1. The commutation circuit is ideal for use in direct current switching where SCR's are used as the principle switching element, because the network interrupts the supply and load current immediately upon initiating the commutation cycle. The circuit does not induce transient current in the supply or load and limits the transient voltages. This solid state innovation should have potential use in spacecraft and aircraft electrical systems, in transportation systems, and in hazardous areas such as mining.

2. The commutation scheme can be extended to chopper circuits where the voltage is controlled by switching and filtering.

3. No additional documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer
Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135
Reference: B73-10004

PATENT STATUS:

NASA has decided not to apply for a patent.

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